# Space Weather Technical Forecast

Issued on Saturday, 30 April 2022 at 13:29 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: G1/Minor geomagnetic storm intervals possible in first half of forecast period, but low confidence. Gradually reducing chance of M-class flares (R1/R2 Radio Blackouts). Increased likelihood of Active fluence on 30th April.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity has been Moderate with three M-class flares observed, all from ex-2994, which is just beyond the western limb. The most energetic of these was a M4.8 flare at 30/0948UTC and may have been accompanied by a CME which is not expected to be Earth-directed. There are four regions on the visible disc. The two in the northwest are 2995 (Hhx/Alpha) and 2997 (Axx/Alpha) which are both benign. Two in the southeast, 2999 (Csi/Beta) and 3001 (Hsx/Alpha) also appear weak, but 2999 has shown signs of recent modest development. No Earth-directed CMEs have been observed in the last 24 hours.

**Solar Wind / Geomagnetic Activity:** The solar wind observed at L1, has been elevated over the last 24 hours due to the waning influence of coronal hole 78, with some modification from a CME, which left the Sun on 27th April. Density was around average, with a slight spike to 10ppcc at 30/0038UTC due to the CME arrival. Total magnetic field strength was mainly weak, but reached moderate levels from 29/2331UTC to 30/0424UTC due to the CME arrival, with a peak of 11nT at 30/0015UTC.The north-south component, Bz, reached a negative peak of -10nT around this time, but otherwise has varied weakly. Phi angle has been negative (towards the Sun) throughout. Geomagnetic activity was mainly Quiet to Unsettled, but with a G1/Minor storm interval between 30/0300-0600UTC.

**Energetic Particles / Solar Radiation:** The high energy proton flux (10 MeV) was at background levels, although there was a limited proton response following a M1 flare on 29th April from ex-2996, with a peak flux of 4.2pfu at 29/2145 UTC. The high energy electron flux (greater than 2MeV) reached high levels on the diurnal peak, 2960 ppcc at 29/1745 UTC. The associated 24-hour fluence remained below the Active (1e8 integrated pfu) level, but rose sharply, with observed fluence of 7.78 integrated pfu at 30/0000UTC. This has since followed a slightly declining trend.

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# Met Office Space Weather Technical Forecast

**Four-Day Space Weather Forecast Summary**
**Solar Activity:** Moderate activity is expected on 30th April, due to the continue effects of ex-2994, which is just beyond the western limb. A return to Low activity is then forecast for the remainder of the period, but this may be modified by how current and returning regions develop.

**Solar Wind / Geomagnetic Activity:** There is the possibility of two CMEs arriving on 30th April, although the first of these appears to have already arrived at Earth. A further CME is considered most likely to glance the Earth on 1st May. Coronal hole 78 is currently waning in influence, with speeds around 500km/s and continuing to fall. No further CMEs or coronal holes are forecast at Earth during the forecast period. Geomagnetic activity is forecast to be Quiet to Unsettled on 30th April and 1st May, with a slight chance of Active or G1/Minor Storm intervals due to any CME effects. Conditions should return to mainly Quiet conditions by 2nd and 3rd May.

**Energetic Particles / Solar Radiation:** The high energy proton flux (greater than 10 MeV) is most likely to remain at background levels through the next four days. Based on the continued existence of the plage region from ex-2996 and the flaring of ex-2994, just beyond the western limb, there is a very slight chance of protons storms. High energy electron flux (greater than MeV) may be suppressed in any significant geomagnetic activity on 30th April and 1st May, with a possibility of high threshold being exceeded on 2nd and 3rd May. The chance of the electron fluence exceeding the Active (1e8 integrated pfu) threshold is likely on 30th April, but with chance through the remainder of the period, dependent on any significant geomagnetic activity.

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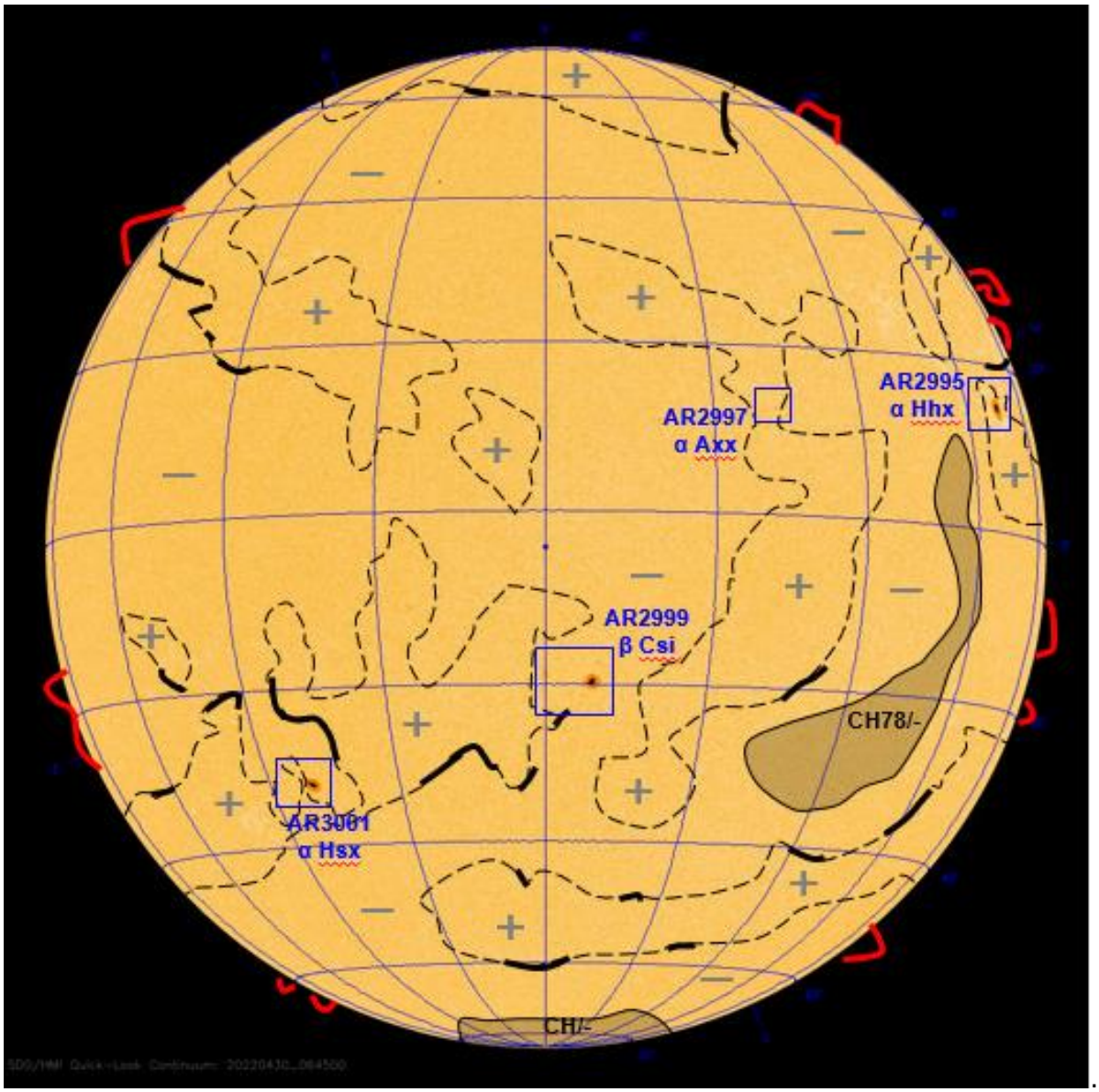
**Figure 1. Solar Analysis Valid 30/0800UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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# Met Office Space Weather Technical Forecast

## Geomagnetic Storms:

There is higher than normal uncertainty in the forecast.
Three CMEs could be en-route to Earth during the forecast period. A CME which left the Sun on 27th April, appears to have arrived late on 29th April. A further CME from 28th April, may arrive on 30th April. A further CME from 29th April may also glance the Earth on 1st May, but current modelling suggests that the bulk of this feature will not affect the Earth.

Coronal hole 78 is also currently affecting the Earth, with speeds waning from 550km/s down to 500km/s. On days 1 and 2 (30th April and 1st May), the easing of the high speed stream may be complicated by the arrival of the CMEs outlined above, with spikes in solar wind speeds and density associated with a CME possible. The solar wind speed is then expected to ease through days 3 and 4 (2nd and 3rd May).

Geomagnetic activity is forecast to be Quiet to Unsettled on days 1 and 2, with a slight chance of Active or G1/Minor Storm intervals due to any CME effects. Conditions should return to mainly Quiet conditions by days 3 and 4.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 20 | 20 | 1 | 1 |
| Strong | G3 | No | 1 | 5 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 27/2138 | Partial | C7 Flare | NW quadrant | 830 km/s | 30/0200 +/-6 hours | Possible glance. |
| 29/1228 | Partial | M1 flare | NW quadrant | 1413km/s | 01/0500UTC | Low confidence |

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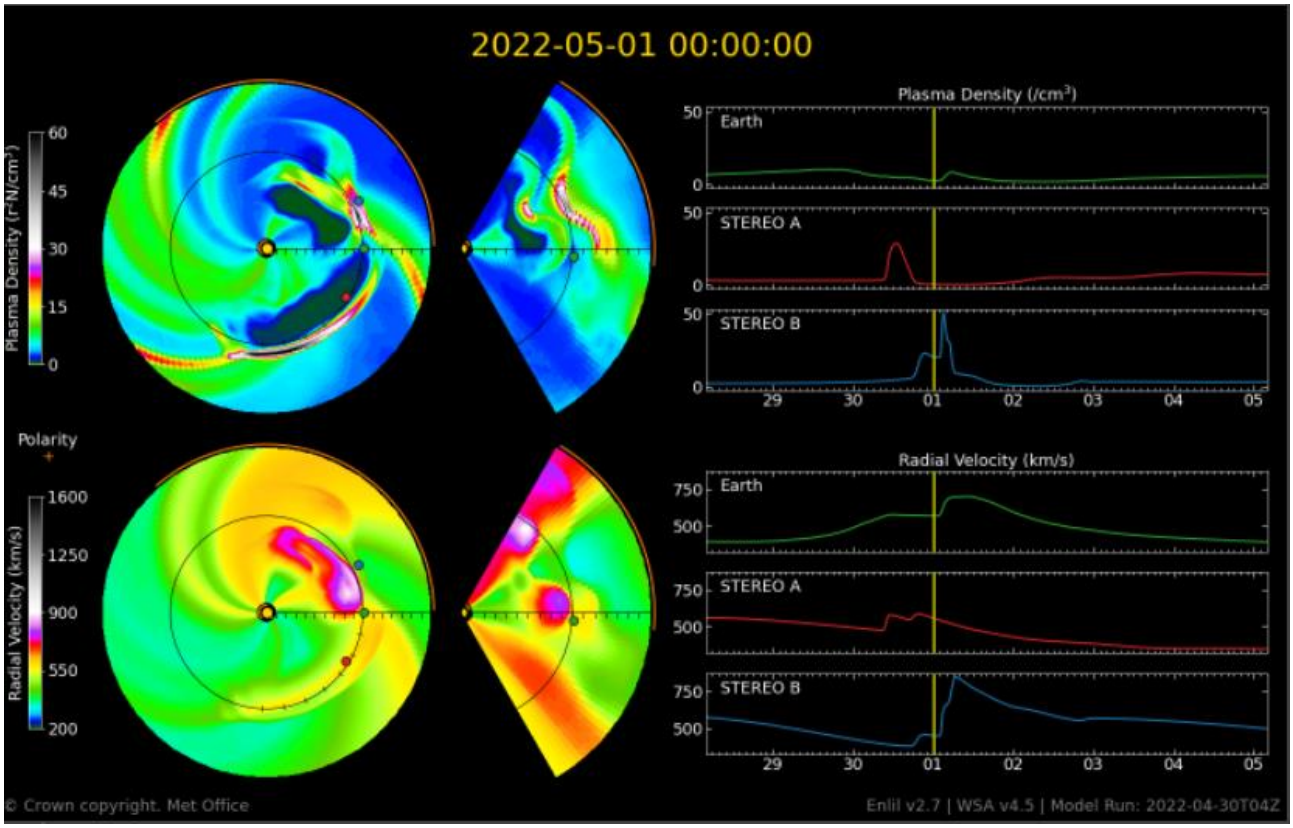
**Figure 2: MOSWOC Enlil modelling of CMEs mentioned in text. Earth is the green dot.**



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**Radio Blackouts - X-Ray Flares:**
The most active region over the last 24 hours has been ex-2994, which is producing M-class flares from just beyond the western limb and two CMEs which on preliminary analysis do not appear to be Earth-directed. Four sunspot regions are on the visible disc. AR2995 (Hhx/Alpha) appears simple and mature. AR2997 (Axx/Alpha) is fading rapidly. In the southeast, AR2999 (Csi/Beta) has shown some modest growth, with AR3001 (Hsx/Alpha) appearing to be stable.

Ex-2994 will rotate away from view over the next 24 hours, with the remaining regions considered benign, although ex-2996, which faded to plage, produced an M-class flare on 29 April. Two regions are forecast to rotate onto the visible disc in the next three days, with ex-2992, which produced an X-class on the last rotation. There is bright flux on the limb on EUVI imagery, which will be monitored as it rotates into view.

Solar activity is expected to be Moderate on day 1 (30th April), but with a falling trend through the period.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 70 | 20 | 10 | 10 |
| Very Active | R3 to R5 X Class | No | 1 | 1 | 1 | 1 |

**Figure 3: GOES 16 X-ray flux**

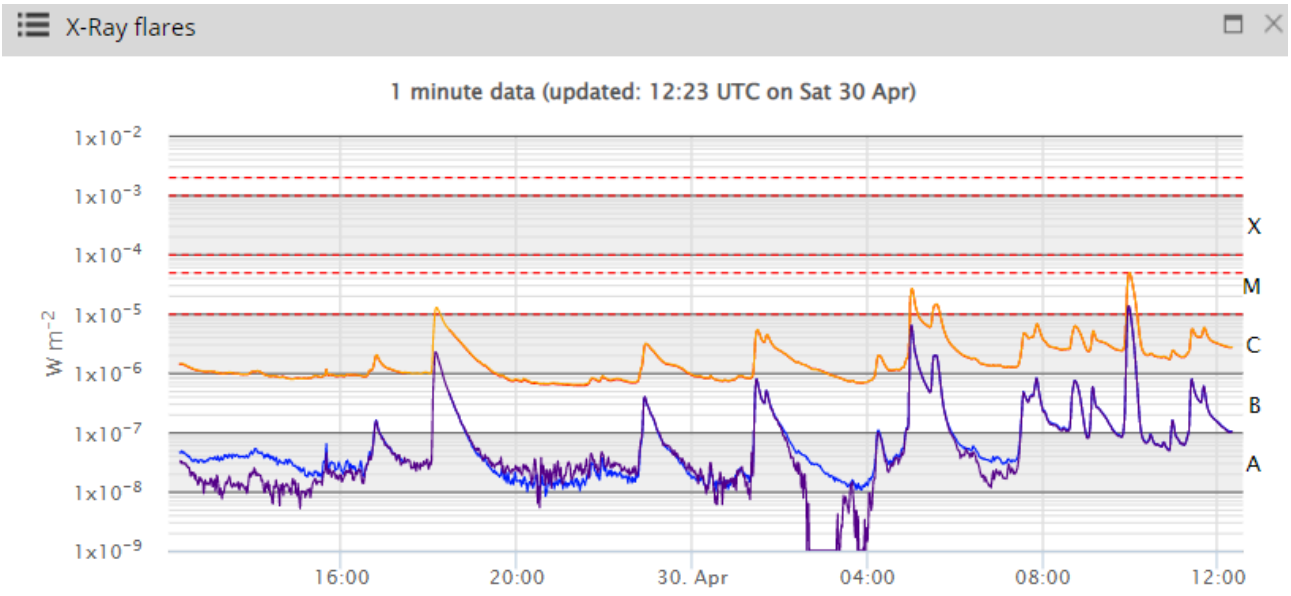


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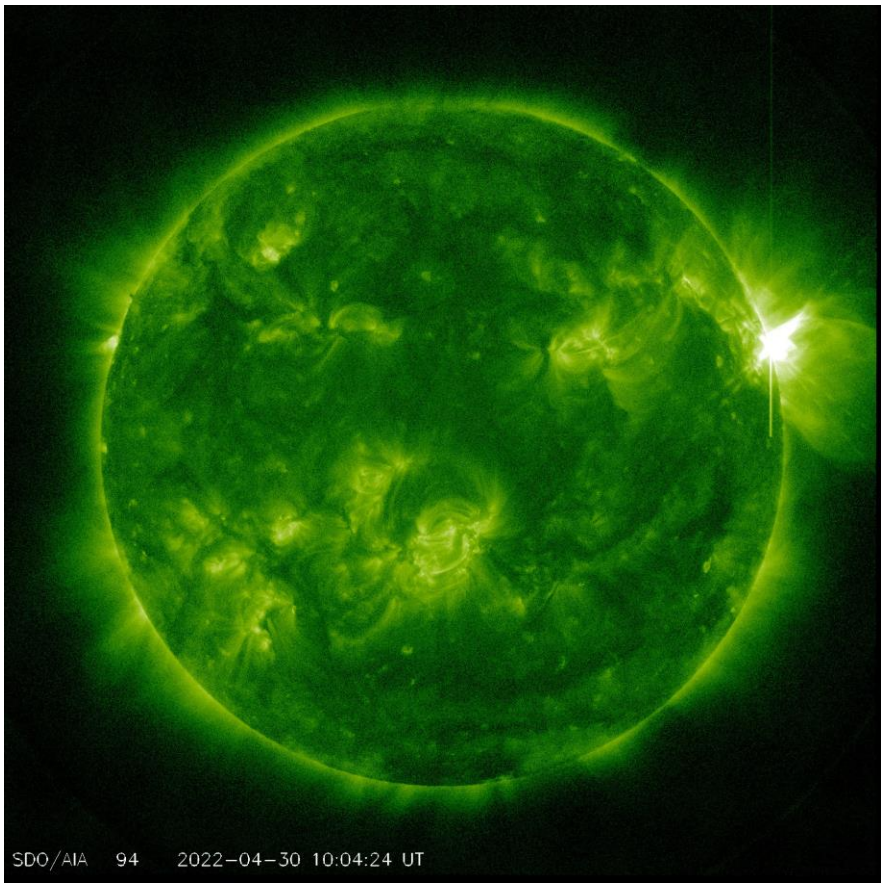
**Figure 4: SDO AIA 94 imagery of flare from ex-2994 just to the top-right limb**




## Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at background levels, and is most likely to remain so through the next four days. However, a limited proton response followed the M1 flare at 29/0730UTC from ex-2996, with a peak flux of 4.2pfu at 29/2145 UTC.

Although ex-2994 has rotated from view, this is still producing significant flares. Ex-2996 is now plage in the northwest quadrant, but the recent history of this region, results in a slight chance of proton storms.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 5 | 5 | 2 | 2 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

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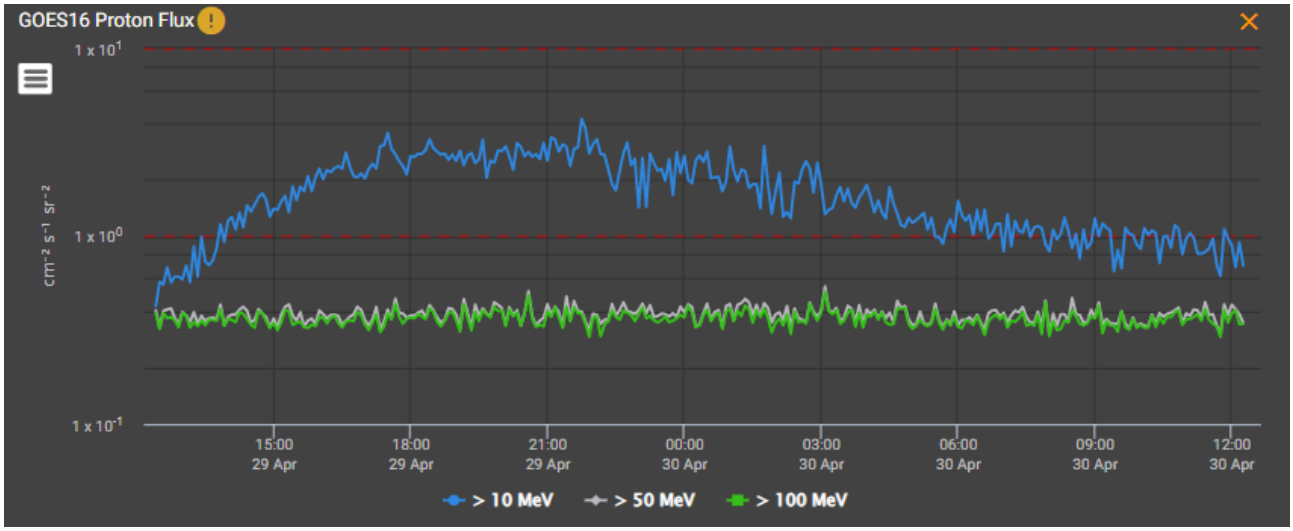
**Figure 5: GOES-16 proton flux**



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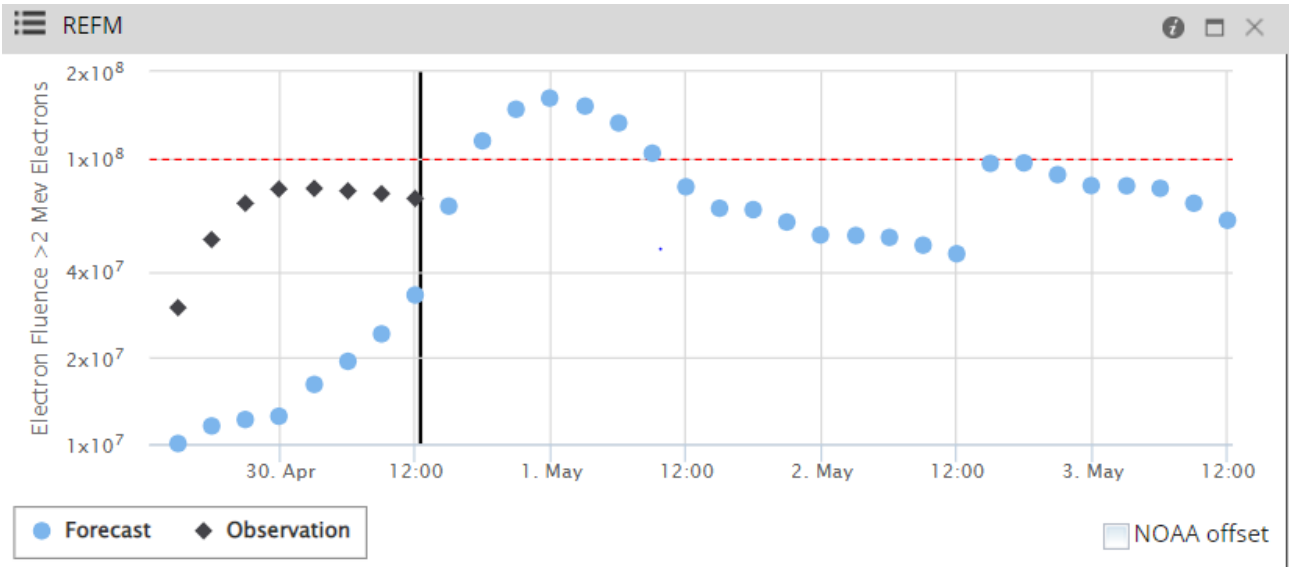
**High Energy Electrons Event (≥ 2MeV):**
High energy electron flux (greater than 2MeV) is currently at background levels following geomagnetic storming, but has been at high levels during the last 24 hours. Further increases are possible through the next four days, but will be subject to potential effects on the radiation belts from any CME arrivals and associated geomagnetic storms on days 1 and 2 (30th April and 1st May). There is an increasing risk of reaching sustained high levels through days 3 and 4.

Electron fluence have started a slight downward trend following the geomagnetic storms. There continues to be a risk of exceeding the Active threshold throughout the period, based on electrons already likely to exist in the radiation belts, but this is subject to modifying factors for the electron flux. A slight risk of exceeding the threshold is still likely on days 3 and 4 due to the chance of high electron flux. MOSWOC REFM modelling seems to give reasonable guidance around the risk of exceeding the Active (1e8 integrated pfu) threshold.

| GEO Electron Environment | Level ($cm^{-2}\,sr^{-1}\,day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 50 | 30 | 30 | 30 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 1 | 1 | 1 |

**Figure 6: MOSWOC REFM electron fluence forecast**

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